

## WHAT IS CLAIMED IS:

1. An optical device comprising a light transmissive plate-shaped light guide for guiding light incident from an end surface, an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first electrode, and a reflection plate provided on a lower surface of said optical control layer through a transparent electrode provided as a second electrode, wherein said optical control layer changes in refractive index by an electric field applied by said first electrode and said second electrode, shows a refractive index substantially same as or greater than that of said plate-shaped light guide when no electric field is applied and shows a small refractive index as compared with said plate-shaped light guide when an electric field is applied, and said reflection plate is made of a light transmissive material, a reflection surface of said reflection plate is angled at a predetermined angle with respect to a surface thereof on said optical control layer side, and a reflection film is formed on said reflection surface.

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2. The optical device as claimed in Claim 1, wherein said reflection surface comprises a sawtooth angled surface group having a predetermined inclination angle.

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3. An optical device comprising a light transmissive plate-shaped light guide for guiding light incident from an end surface, an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first electrode, and a reflection plate made of a light transmissive plate provided on a lower surface of said optical control layer through a second electrode comprising said transparent electrode,

15 wherein said optical control layer is made of a reverse mode polymer dispersed liquid crystal changing in scattering degree by an electric field applied by said first electrode and said second electrode, which is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and said optical control layer becomes a uniform birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

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4. An optical device comprising a light transmissive plate-shaped light guide for guiding light incident from an end surface, an optical control layer provided on a lower surface of said plate-shaped light guide  
5 through a transparent electrode provided as a first electrode, and a second electrode which is an electrode provided on a lower surface of said optical control layer for making mirror reflection of light,

wherein said optical control layer is made of a  
10 reverse mode polymer dispersed liquid crystal changing in scattering degree by an electric field applied by said first electrode and said second electrode, which is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and  
15 said optical control layer becomes a uniform birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

20 5. An optical device comprising a light transmissive plate-shaped light guide for guiding light incident from an end surface, an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first  
25 electrode, and a reflection plate made of a light transmissive plate provided on a lower surface of said

optical control layer through a transparent electrode provided as a second electrode,

wherein said optical control layer changes in diffraction ability by an electric field applied by  
5 said first electrode and said second electrode.

6. An optical device comprising a light transmissive plate-shaped light guide for guiding light incident from an end surface, an optical control layer provided  
10 on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first electrode, and a second electrode which is an electrode provided on a lower surface of said optical control layer for making mirror reflection of light,

15 wherein said optical control layer changes in diffraction ability by an electric field applied by said first electrode and said second electrode.

7. The optical device as claimed in Claim 5, wherein  
20 said optical control layer comprises one of constructions of liquid crystal particles dispersed in a polymer resin area, a polymer dispersed liquid crystal comprising polymer resin particles dispersed in a liquid crystal, and a polymer dispersed liquid  
25 crystal in which respective polymer resin area and liquid crystal area form continuous areas, wherein

said liquid crystal has a structure periodically distributed in the form of a diffraction grating.

8. The optical device as claimed in Claim 6, wherein  
5 said optical control layer comprises one of constructions of liquid crystal particles dispersed in a polymer resin area, a polymer dispersed liquid crystal comprising polymer resin particles dispersed in a liquid crystal, and a polymer dispersed liquid  
10 crystal in which respective polymer resin area and liquid crystal area form continuous areas, wherein said liquid crystal has a structure periodically distributed in the form of a diffraction grating.

15 9. The optical device as claimed in Claim 5, wherein said optical control layer comprises a holographic polymer dispersed liquid crystal.

10. The optical device as claimed in Claim 6, wherein  
20 said optical control layer comprises a holographic polymer dispersed liquid crystal.

11. The optical device as claimed in Claim 5, wherein  
25 said optical control layer is made of a reverse mode polymer dispersed liquid crystal which is constructed by dispersing a low molecular-weight liquid crystal

in a liquid crystalline polymer, and said optical control layer becomes a uniform birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

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12. The optical device as claimed in Claim 6, wherein said optical control layer is made of a reverse mode polymer dispersed liquid crystal which is constructed by dispersing a low molecular-weight liquid crystal  
10 in a liquid crystalline polymer, and said optical control layer becomes a uniform birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

15 13. An optical device comprising a light transmissive plate-shaped light guide for guiding light incident from an end surface, an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first  
20 electrode, a second electrode provided on a lower surface of said optical control layer, and a substrate provided on a lower surface of said second electrode, wherein at least one of said first electrode and said second electrode has

a periodic structure for inducing a fine periodic structure for light diffraction in said optical control layer, and

5 said optical control layer changes in refractive index or absorptivity or scattering degree by an electric field applied by said first electrode and said second electrode.

14. The optical device as claimed in Claim 1, wherein  
10 at least one of said first electrode and second electrode comprises an electrode group divided into strips, when both of said first electrode and second electrode comprise electrode groups divided into strips, said plurality of strip-formed electrodes  
15 constituting said first electrode and said plurality of strip-formed electrodes constituting said second electrodes are disposed to be perpendicular to each other.

20 15. The optical device as claimed in Claim 2, wherein at least one of said first electrode and second electrode comprises an electrode group divided into strips, when both of said first electrode and second electrode comprise electrode groups divided into  
25 strips, said plurality of strip-formed electrodes constituting said first electrode and said plurality

of strip-formed electrodes constituting said second electrodes are disposed to be perpendicular to each other.

5 16. The optical device as claimed in Claim 3, wherein  
at least one of said first electrode and second  
electrode comprises an electrode group divided into  
strips, when both of said first electrode and second  
electrode comprise electrode groups divided into  
10 strips, said plurality of strip-formed electrodes  
constituting said first electrode and said plurality  
of strip-formed electrodes constituting said second  
electrodes are disposed to be perpendicular to each  
other.

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17. The optical device as claimed in Claim 4, wherein  
at least one of said first electrode and second  
electrode comprises an electrode group divided into  
strips, when both of said first electrode and second  
20 electrode comprise electrode groups divided into  
strips, said plurality of strip-formed electrodes  
constituting said first electrode and said plurality  
of strip-formed electrodes constituting said second  
electrodes are disposed to be perpendicular to each  
25 other.



18. The optical device as claimed in Claim 5, wherein  
at least one of said first electrode and second  
electrode comprises an electrode group divided into  
strips, when both of said first electrode and second  
5 electrode comprise electrode groups divided into  
strips, said plurality of strip-formed electrodes  
constituting said first electrode and said plurality  
of strip-formed electrodes constituting said second  
electrodes are disposed to be perpendicular to each  
10 other.

19. The optical device as claimed in Claim 6, wherein  
at least one of said first electrode and second  
electrode comprises an electrode group divided into  
15 strips, when both of said first electrode and second  
electrode comprise electrode groups divided into  
strips, said plurality of strip-formed electrodes  
constituting said first electrode and said plurality  
of strip-formed electrodes constituting said second  
20 electrodes are disposed to be perpendicular to each  
other.

20. The optical device as claimed in Claim 10, wherein  
at least one of said first electrode and second  
25 electrode comprises an electrode group divided into  
strips, when both of said first electrode and second

electrode comprise electrode groups divided into strips, said plurality of strip-formed electrodes constituting said first electrode and said plurality of strip-formed electrodes constituting said second  
5 electrodes are disposed to be perpendicular to each other.

21. The optical device as claimed in Claim 1, wherein one of said first electrode and second electrode is  
10 divided into display pixel units and each of said divided display pixel units has a switching device.

22. The optical device as claimed in Claim 2, wherein one of said first electrode and second electrode is  
15 divided into display pixel units and each of said divided display pixel units has a switching device.

23. The optical device as claimed in Claim 3, wherein one of said first electrode and second electrode is  
20 divided into display pixel units and each of said divided display pixel units has a switching device.

24. The optical device as claimed in Claim 4, wherein one of said first electrode and second electrode is  
25 divided into display pixel units and each of said divided display pixel units has a switching device.

25. The optical device as claimed in Claim 5, wherein  
one of said first electrode and second electrode is  
divided into display pixel units and each of said  
6 divided display pixel units has a switching device.

26. The optical device as claimed in Claim 6, wherein  
one of said first electrode and second electrode is  
divided into display pixel units and each of said  
10 divided display pixel units has a switching device.

27. The optical device as claimed in Claim 10, wherein  
one of said first electrode and second electrode is  
divided into display pixel units and each of said  
15 divided display pixel units has a switching device.

28. An optical device comprising a light transmissive  
plate-shaped light guide for guiding light incident  
from an end surface, an optical control layer provided  
20 on a lower surface of said plate-shaped light guide,  
periodic electrodes having periodic structures  
disposed in alternation and provided on a lower surface  
of said optical control layer for inducing a fine  
periodic structure for light diffraction in said  
25 optical control layer, and a substrate provided on a

lower surface of said periodic electrodes disposed in alternation,

wherein said optical control layer changes in refractive index or absorptivity or scattering degree  
5 by an electric field applied by said periodic electrodes disposed in alternation.

29. The optical device as claimed in Claim 28, wherein said electrode having periodic electrodes disposed in  
10 alternation is provided for each of display pixel units, and each of said divided display pixel units has a switching device.

30. An optical device comprising: a light  
15 transmissive plate-shaped light guide for guiding light incident from an end surface; an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first electrode; a second electrode having a  
20 plurality of divided electrodes, and a plurality of third electrodes one to one corresponding to each of said plurality of divided second electrodes and penetrating through said substrate,

wherein said optical control layer changes in  
25 refractive index or absorptivity or scattering degree

by an electric field applied by said first electrode and said second electrode,

each of said plurality of third electrodes has a first end part connecting to said second electrode and  
5 a second end part exposed to a surface opposite to said second electrode side surface of said substrate, and

said respective electrodes are capable of being applied with a voltage from said substrate side discretely or dividedly in an optional number of  
10 groups.

31. An optical device comprising: a light transmissive plate-shaped light guide for guiding light incident from an end surface; a first stacked  
15 body integrated with an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first electrode; and a second stacked body integrated with each of substrate divided into a plurality of units,

20 wherein said second stacked body corresponds one to one to each of said second electrode divided into a plurality of units and a substrate provided on a lower surface of said electrode, has a plurality of third electrodes penetrating through said substrate, and  
25 arranged on a lower surface of said optical control layer,

said optical control layer changes in refractive index or absorptivity or scattering degree by an electric field applied by said first electrode and second electrode,

5 each of said plurality of third electrodes has a first end part connecting to said second electrode and a second end part exposed to a surface opposite to said second electrode side of said substrate, and said respective electrodes are capable of being applied  
10 with a voltage from said substrate side discretely or dividedly in an optional number of groups.

32. A display apparatus comprising an optical device and a illumination means for applying light to said  
15 optical device, wherein

said optical device has an end surface for incident light from said illumination means, a light transmissive plate-shaped light guide for guiding incident light, an optical control layer provided on  
20 a lower surface of said plate-shaped light guide and changing in refractive index by an electric field applied through a transparent electrode provided as a first electrode, and a reflection plate provided on a lower surface of said optical control layer through  
25 a transparent electrode provided as a second electrode,

wherein said optical control layer has a liquid crystal exhibiting a refractive index substantially same as or greater than that of said plate-shaped light guide when no electric field is applied and a small  
5 refractive index as compared with said plate-shaped light guide when an electric field is applied, and

said reflection plate is made of a light transmissive material, a reflection surface of said reflection plate opposite to said optical control  
10 layer side is angled at a predetermined angle with respect to a side surface of said optical control layer, and a reflection film is provided on said reflection surface.

15 33. The display apparatus as claimed in Claim 32, wherein said reflection surface comprises a sawtooth angled surface group having a predetermined inclination angle.

20 34. A display apparatus comprising an optical device and a illumination means for applying light to said optical device, wherein

said optical device has an end surface for incident light from said illumination means, a light  
25 transmissive plate-shaped light guide for guiding incident light, an optical control layer provided on

a lower surface of said plate-shaped light guide, and a reflection plate made of a light transmissive plate provided on a lower surface of said optical control layer through a transparent electrode provided as a  
5 second electrode,

wherein said optical control layer is made of a reverse mode polymer dispersed liquid crystal changing in scattering degree by an electric field applied by said first electrode and said second electrode, which  
10 is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and said optical control layer becomes a uniform birefringent thin film when no electric field is applied and becomes a scattering state when an electric  
15 field is applied.

35. A display apparatus comprising an optical device and a illumination means for applying light to said optical device, wherein  
20 said optical device has an end surface for incident light from said illumination means, a light transmissive plate-shaped light guide for guiding incident light, an optical control layer provided on a lower surface of said plate-shaped light guide  
25 through a transparent electrode provided as a first electrode, and a second electrode provided as an



electrode on a lower surface of said optical control layer for making mirror reflection of light,

wherein said optical control layer is made of a reverse mode polymer dispersed liquid crystal changing  
5 in scattering degree by an electric field applied by said first electrode and said second electrode, which is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and said optical control layer becomes a uniform  
10 birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

36. A display apparatus comprising an optical device  
15 and a illumination means for applying light to said optical device, wherein

said optical device has an end surface for incident light from said illumination means, a light transmissive plate-shaped light guide for guiding  
20 incident light, an optical control layer provided on a lower surface of said plate-shaped light guide, and a reflection plate made of a light transmissive plate provided on a lower surface of said optical control layer through a transparent electrode provided as a  
25 second electrode,

wherein said optical control layer changes in diffraction ability by an electric field applied by said first electrode and said second electrode.

- 5 37. A display apparatus comprising an optical device and a illumination means for applying light to said optical device,

said optical device has an end surface for incident light from said illumination means, a light  
10 transmissive plate-shaped light guide for guiding incident light, an optical control layer provided on a lower surface of said plate-shaped light guide through a transparent electrode provided as a first electrode, and a second electrode provided as an  
15 electrode on a lower surface of said optical control layer for making mirror reflection of light,

wherein said optical control layer changes in diffraction ability by an electric field applied by said first electrode and said second electrode.

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38. The display apparatus as claimed in Claim 36, wherein said optical control layer comprises one of constructions of liquid crystal particles dispersed in a polymer resin area, a polymer dispersed liquid  
25 crystal comprising polymer resin particles dispersed in a liquid crystal, and a polymer dispersed liquid

crystal in which respective polymer resin area and liquid crystal area form continuous areas, wherein said liquid crystal has a structure periodically distributed in the form of a diffraction grating.

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39. The display apparatus as claimed in Claim 37, wherein said optical control layer comprises one of constructions of liquid crystal particles dispersed in a polymer resin area, a polymer dispersed liquid crystal comprising polymer resin particles dispersed in a liquid crystal, and a polymer dispersed liquid crystal in which respective polymer resin area and liquid crystal area form continuous areas, wherein said liquid crystal has a structure periodically distributed in the form of a diffraction grating.

40. The display apparatus as claimed in Claim 36, wherein said optical control layer comprises a holographic polymer dispersed liquid crystal.

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41. The display apparatus as claimed in Claim 37, wherein said optical control layer comprises a holographic polymer dispersed liquid crystal.

42. The display apparatus as claimed in Claim 36, wherein said optical control layer is made of a reverse

mode polymer dispersed liquid crystal which is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and said optical control layer becomes a uniform  
5 birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

43. The display apparatus as claimed in Claim 37,  
10 wherein said optical control layer is made of a reverse mode polymer dispersed liquid crystal which is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and said optical control layer becomes a uniform  
15 birefringent thin film when no electric field is applied and becomes a scattering state when an electric field is applied.

44. A display apparatus comprising an optical device  
20 and a illumination means for applying light to said optical device;

said optical device having an end surface for incident light from said illumination means, a light transmissive plate-shaped light guide for guiding  
25 incident light, an optical control layer provided on a lower surface of said plate-shaped light guide

through a transparent electrode provided as a first electrode, a periodic electrode provided as a second electrode having a periodic structure provided on a lower surface of said optical control layer for  
5 inducing a fine periodic structure for light diffraction in said optical control layer, and a substrate provided on a lower surface of said second electrode.

wherein at least one of said first electrode and  
10 said second electrode has a periodic structure for inducing a fine periodic structure for light diffraction in said optical control layer, and

said optical control layer changes in refractive  
15 index or absorptivity or scattering degree by an applied electric field, and is made of a reverse mode polymer dispersed liquid crystal changing in refractive index or absorptivity or scattering degree by an electric field applied by said first electrode  
20 and said second electrode, which is constructed by dispersing a low molecular-weight liquid crystal in a liquid crystalline polymer, and said optical control layer becomes a uniform birefringent thin film when no electric field is applied and becomes a scattering  
25 state when an electric field is applied.